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ABSTRACT

As part of a review of technological studies in the province of Ontario, the industrial arts programs of middle schools and junior high schools in the North York school system were evaluated. The review was undertaken to: (1) determine current student enrollment and time allocation patterns for industrial arts courses; (2) examine the extent to which the core aims and expected practices--as defined in the "North York Industrial Arts Guideline"--were delivered; and (3) examine future industrial arts staffing requirements. Interviews were conducted with 36 of the 37 teachers of industrial arts in grades 7 and 8. Overall, teachers were meeting the core aims of the curriculum, since students were involved in problem solving and were applying abstract knowledge of design, materials, and processes to practical problems. Most teachers felt that they were at least partially successful in fostering students' creativity, and 75% used a combination of techniques to instill creativity. Students' difficulties in planning projects and the ways teachers approached these difficulties are discussed. A variety of methods, including written or oral tests and assessments of research assignments and drawings, were used to evaluate student work; practical tests were often used to provide evidence of student knowledge. Safety considerations were often emphasized. Integration with other disciplines and the study of scientific principles were emphasized less frequently and given a relatively low priority. Fifteen data tables are included. (SLD)

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INDUSTRIAL ARTS REVIEW

Report to Committee

Sandra Sangster, Margaret Fagan

April 1988

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INDUSTRIAL ARTS REVIEW

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INDUSTRIAL ARTS REVIEW

INTRODUCTION

Mandate

In a Ministry memorandum issued in conjunction with the new Technological Studies Guideline (Part A), school boards across the province of Ontario were instructed to initiate an internal review and planning process that would provide direction for programs falling under the umbrella of technological studies. Since industrial arts is now considered by the Ministry of Education to be a program that is part of technological studies, the Technological Studies Review Planning Committee determined that Phase II of the three phases of the review would focus on industrial arts at the middle school and the junior high school levels.

Planning and Review Committees

In January 1988, Planning and Review Committees were established by the Superintendent of Curriculum and Staff Development Services in order to conduct the industrial arts review. The objectives established for the Planning Committee were:

- to set the major objectives for the review
- to plan and organize review activities
- to establish and organize the review committee structure and itinerary required to conduct the review activities
- to develop preliminary drafts of the instruments required to gather review data.

The objectives for the Review Committee were as follows:

- to modify and approve the research instruments
- to review and analyse the data gathered
- to produce a report, to be included as part of the Director's Quality Assurance Report, outlining the findings of the Review and providing recommendations that will assist with the short and long range planning for the delivery of industrial arts programs to the students of North York.

Major Objectives of the Review

The review was undertaken to provide information related to the following objectives:

- to determine the current student enrolment and the time allocation patterns for industrial arts programs in middle schools and junior high schools

- to examine the extent to which the core aims and the expected practises, as articulated in the North York Industrial Arts Guideline, are delivered in the Intermediate Grades, 7, 8 and 9
  - Core Aims of Industrial Arts
  - Elements of a Comprehensive Industrial Arts Program
  - Content Objectives of the Foundation Program

- to examine future industrial arts staffing requirements.

METHODOLOGY

In view of the mandate from the Planning Committee to complete the review by May 1988, the focus of the review was limited to the Foundation Program outlined in The Industrial Arts Guideline. The extent to which North York teachers have implemented elements of the Industrial Arts Selective Program was not examined.

It was also determined that data collection would be limited to the following sources:

- enrolment statistics provided to the Coordinator of Technological Studies by Computer Services staff, with additional statistics provided by school staff and the Board's Planning Department
- questionnaires completed by all middle and junior high School industrial arts teachers
- personal interviews with all middle and junior high school industrial arts teachers regarding the program they deliver.

This report provides a detailed summary of the results of the teacher interviews and the brief questionnaire regarding areas of program emphasis.

Development of the Interview Schedule and Questionnaire

The interview schedule was designed to gather the detailed information from teachers about the program they deliver to students and strategies used to deliver that program. The section in the North York Industrial Arts Guideline entitled "Elements of a Comprehensive Industrial Arts Program" provided the basis for the development of this instrument. A draft was prepared by Research Department Staff and revised in consultation with the Review Committee.

A copy of this instrument is provided in Appendix K of the full Industrial Arts Review Report.

In order to provide confirmation of the interview data, teachers also completed a brief questionnaire in which they rated areas of program emphasis. This questionnaire was developed by a member of the Review Committee and is provided in Appendix L of the complete Industrial Arts Review Report.

Data Collection Procedures

A memo to all middle and junior high school principals was sent from the Superintendent of Curriculum and Staff Development informing them of the industrial arts review and requesting their cooperation in arranging the times for the teacher interviews. Prior to the collection of any data, a meeting of all industrial arts teachers was held. Teachers were provided with

information about the review by the Coordinator of Technological Studies, the Program Leader for Industrial Arts and representatives of Research and Evaluation Services.

Two members of Research and Evaluation Services conducted interviews with 36 of the 37 teachers of Grade 7 and 8 industrial arts (the remaining teacher was unavailable due to illness). The interviews averaged one hour in length. The results of the brief questionnaire regarding areas of program emphasis and teachers' interview comments were summarized by staff of Research and Evaluation Services.

FINDINGS

I. Teacher Interviews: Core Aims and Elements of a Comprehensive Industrial Program

The results of the interviews with intermediate level industrial arts teachers are summarized in the following sections:

- Materials and Tools
- Processes
- Design, Creativity and Problem-Solving
- Planning and Organization
- Integration with other Subject Curricula
- Evaluation Strategies
- Safety
- Leisure
- Additional General Comments.

Materials and Tools

In the Elements of a Comprehensive Industrial Program it states that the student should become familiar and work with a **wide variety of materials:** wood, metals and plastics being a minimum. Research (material study) into the structure, properties and appropriate uses of these materials should be incorporated into the program.

Of the 36 teachers interviewed, 97 percent use woods as material, with 92 percent indicating that students work with metals. Eighty-three percent use plastics such as acrylic, plexiglass, styrofoam and vinyls.

Thus, almost all the industrial arts teachers interviewed are fulfilling the minimum requirement regarding the use of a "wide variety of materials" (i.e. wood, metal and plastic). Only 27% had extended their program beyond this into more unusual materials such as felt, paper, stone, glass, mirror, fibreglass, rubber, masonite, stained glass, enamels and lapidary work.

Teachers were asked to indicate whether they incorporated **research about material study** into their program, and if so to describe. Two thirds replied that they did not do this or only did it incidentally. The most frequently cited reference material was the textbook, followed by the library resources and reference material in the industrial arts room. The focus by most teachers is on activity as opposed to research, with the research that is done tending to focus on a particular project. For example, students may do research when they need to learn about the structure of wood, on the properties and characteristics of metals or how materials react to certain processes.

The development of competence in the use of hand and machine tools is one of the core aims of industrial arts. Thus, teachers were asked to what degree machine tools are used in grades 7, 8 and 9. They generally found the question difficult to answer because of the wide variety of tools in use.

The following table lists the tools used by grade level based on the small number of teachers who provided that information:

- Grade 6
  - hand tools
  - no machine tools specifically listed

- Grade 7
  - hand tools, wood router (with guidance), jig saw, sheet metal formers, forge, buffer, sander, metal lathe, wood lathe, drill press, spot welders, metal squaring shear, grinder, vibrotool, metal soldering furnace, strip-heater, blow former

- Grade 8
  - those in grade 6 and 7
  - add band saw, sabre saw, gas welding, sandblasting

- Grade 9
  - those in grade 6, 7 and 8
  - add autobody grinder, jointer (setup), (setup) thickness planer, (setup) table saw, belt sander.

Thus the core aim in the Industrial Arts Guideline related to the development of competence in the use of hand and machine tools and in the use of various materials is being met based on the variety of hand and machine tools and materials listed by teachers.

Processes

Another of the Elements of a Comprehensive Industrial Arts Program involves familiarizing students with the **four basic material forming processes:** pressure forming, fabrication, casting and stock removal. The guideline states that the processes should include operations with hand and machine tools.

In order to examine the extent to which this element is being covered, teachers were asked to describe the basic material forming processes they teach. About half of the teachers interviewed do not include casting among the processes covered; twenty percent do not cover pressure forming. The following summarizes the percentage of teachers covering each process:

Material Forming Processes	%
. Stock removal	91
. Fabrication	88
. Pressure forming	80
. Casting	47

In each case, teachers listed examples of the ways they use these processes. These are highlighted below:

- **Pressure Forming:**

  e.g. - blow, bending and injection molding (plastic)
  - strip heater and oven (plastic)
  - contour forming (wood, plastic)
  - wood laminating, molding/bending
  - bar folder (sheet metal)
  - box and pan brake (sheet metal)
  - slip roll former (sheet metal)
  - smithing (tin, silver and blacksmithing)

- **Fabrication:**

  e.g. - lamination
  - wood joinery
  - brazing
  - spot welding
  - glue and nail, wood screws
  - soldering
  - mechanical joints

- **Casting:**

  e.g. - cast wax and metal alloys with low melting temperatures
  - plastic casting (embedding)

- **Stock Removal:**

  e.g. - carving
  - spindle turning
  - saws (jigsaw, handsaw, hacksaw, scrollsaw)
  - wood and metal lathes
  - cutting machines
  - drills
  - chisels, files
  - sander, grinder
  - bolt cutter

The teachers were also asked if they had introduced any new materials and/ or processes during the past three years. Thirty-three percent reported introducing new processes, 17 percent introduced new materials, and a further 17 percent introduced both. The remaining 33% of teachers had not incorporated new processes or materials into their programs. The following were listed as examples of the new processes and materials covered:

- different types of plastics
- copper enamelling
- stained glass
- lapidary work
- paper and cardboard
- plywood and exotic woods
- spaghetti glued to wood to construct a model crane
- a house reconstruction project
- use of a computer for graphics and word processing.

The reasons given for covering these new materials and processes included the increasing use of plastics in our society and the need to understand it and its uses, increased student interest (especially of females) in stained glass, and the interests of the principal and teacher.

Design, Creativity and Problem Solving

Two of the core aims of industrial arts education are to develop the capacity to analyse, plan, construct and evaluate useful objects of good design through the use of tools and materials, and to develop an appreciation of high standards of good design and craftmanship. "Design is the total process of seeking a simple and direct solution to a problem..." Students are to be instructed in design appreciation, the elements of design and principles of design, and should acquire design knowledge and skills. In addition, three of the general aims of technological studies are to develop the capacity for clear and creative thinking, to develop the ability to perform a task using the logical sequence of operations, and to stimulate the qualities of intellectual curiosity and imagination towards continued learning and problem-solving.

Thus, design and creativity are included as two of the elements of a comprehensive industrial arts program. The North York Guideline recommends that:

1) Design considerations precede or accompany all practical work undertaken by the student. The problem-solving approach and process are recommended.

2) As much as possible, when skills of the student permit, individual creativity should be encouraged. Even teacher designed projects, in most cases, should allow some element of individuality by the student.

In order to examine the extent to which these guidelines regarding **design, creativity and problem-solving** have been implemented, teachers were asked a number of questions regarding techniques used to encourage design, creativity and problem-solving skills in their students, as well as the degree of success and problems encountered in implementing such a program.

When teachers were asked if they taught specific **"design" lessons,** 19% (7) responded that they do not, 56% (20) indicated that they give specific design lessons, and a further 25% (9) said that they teach design incidentally. Hence, most teachers teach design specifically or incidentally.

Most teachers felt they are very successful in **fostering creativity:** 61% (22) of the teachers indicated that they are very successful, 28% (10) reported they are partially successful, and 11% (4) stated that they are not very successful.

When teachers were asked to estimate the **proportion of students who design their own projects,** one third indicated that the majority of their students do so throughout the intermediate grades. Slightly more than half of the teachers (53%) indicated that the proportion of students who design their own projects increases by grade level, and the projects progress from being teacher-directed to more student-directed. These teachers' estimates of the progression in the proportions of students designing their own projects at different grade levels varied widely. The estimated proportion of grade 6 and 7 students who design their own projects ranged from a low of zero to 60 percent. For grade 9 students, the estimates ranged from 30 to 100 percent.[1] Of the teachers interviewed, a further eight percent (3) reported that all students alter designs provided by the teacher with no apparent progression in the proportion of students who design their own projects; the remaining six percent (2) commented simply that students do not design their own projects.

Teachers were asked **how they encourage their students to be creative** and to list the types of **strategies they use to introduce the concept of design** to their students. The teachers each used a variety of techniques, incorporating many of the suggestions provided in the guideline. The same categories of answers emerged for both of these questions although the emphasis differed.

Developing Creativity and Design Skills	Question on Creativity		Question on Design	
	N	%	N	%
. Design own project	16	44	8	22
. Problem-solving and multiple solutions	14	39	9	25
. Alter teacher's design	12	33	4	11
. Provide general ideas from other sources	5	14	14	39
. Verbal encouragement to try alternative	5	14	2	6
. Teach drawing and modelling	3	8	11	31
. Group work and discussion	2	6	11	31
. Show them examples and teach design	2	6	3	8
. Variety of materials	2	6	2	6
. No answer	-	-	1	3

1. These divergent estimates may be due in part to differing interpretations of the term "design their own projects". For some teachers the term means altering a design provided by the teacher whereas for others it implies an original design by the student.

The strongest emphasis for the question about creativity was on designing their own project (44%) (i.e., an original, individual, student-designed project), problem-solving with multiple solutions (39%) (i.e., open-ended problem for which they find multiple solutions and select one as their "core problem") and altering a design given by the teacher (33%) (i.e., a teacher-designed project which the student partially redesigns, e.g., shape, details or size).

The strongest emphasis for the question on design was on providing general ideas from other sources (39%) (i.e., books, magazines, samples and commercial products). Thirty-one percent reported the use of models and drawing (which involved discussing proportion, teaching sketching and design, giving exercises on design and emphasizing model construction to check design. Another 31% reported that they used group work and discussions which involved brainstorming in groups and asking all students for a unique solution to the problem to be discussed.

There was moderate emphasis for the question about creativity on providing general ideas from other sources (14%) and verbal encouragement (14%) (i.e., encourage them not to be satisfied with their first choice or tell them to try something different).

There was a moderate emphasis for the question about design on problem solving and multiple solutions (25%), designing their own projects (22%) and altering the teacher's design (11%).

There was little emphasis, overall, in showing students examples and teaching design (i.e., sources of good design in geometry, nature, abstract or doodle; reshaping their ideas; showing them different ideas which they can alter), and the use of a variety of materials (i.e., improvising; different things to do with materials; encourage use of various materials).

Teachers were also questioned about the **difficulties encountered in incorporating a design component into the program and the problems encountered by students when designing their own projects.** As with the creativity and design questions, similar categories of responses emerged for the two questions although there was a different emphasis for each.

Difficulties Incorporating Design into Program	Difficulties of Teacher		Difficulties of Students	
	N	%	N	%
. insufficient time	17	47	4	11
. students lack background	12	33	13	36
. students lack self-confidence	10	28	10	28
. students are impatient and don't want to take time to design	7	19	4	11
. students lack ideas for designs	3	8	8	22
. students have grandiose ideas	3	8	6	17
. students have problems drawing	2	6	6	17
. other responses	8	22	8	22
. none	2	6	3	8

The difficulty encountered most often by teachers in incorporating a design component was lack of time (47%), providing such comments as:

- there are limited hours in the trisemester system
- making them create and design their own projects reduces time for practical work
- teachers need to spend time with students individually
- teachers have limited time in two separate shops
- teachers also want their students to complete the project and to learn about tools.

Also cited frequently was the lack of background (33%) students have in design, processes, materials and machinery (e.g., limited from using certain machines due to age and limited ideas for design as they do not know how to form metal). The third major emphasis was students' lack of self-confidence and a desire to be told what to do (28%). The students are insecure and not keen on taking risks, preferring to make something designed by the teachers or copy from others. There was a moderate emphasis on students' impatience and unwillingness to take the time to design their own projects (19%). Teachers commented that students do not like designing and often do not view design as part of the project.

The strongest emphasis for the difficulties encountered by the students in designing projects was their lack of background, knowledge or skill of materials and processes which limits their ideas for design (36%). There are also limitations in the equipment they can use due to regulations. The second major emphasis was the lack of self-confidence and the desire to be told what to do (28%). Students' lack of ideas for designs due to limited life experience or reliance on unimaginative preconceived ideas was cited moderately often (22%). Another 17% of teachers stated that their students have grandiose ideas, over-design and do not estimate well the time it takes them to build something. Students' ideas are often greater than their knowledge of the materials required to construct the project. A further 17% mentioned that students have problems in drawing related to accuracy, proportion, and sketching three-dimensional shapes.

Some of the teachers outlined how they attempt to help their students overcome these problems. Twenty-eight percent (10) provided **suggestions for overcoming problems related to lack of background** such as following:

- redesigning the project so that students can utilize the machines that they are allowed to use
- pointing out the limitations of materials and discussing them with students
- testing samples of materials and techniques (e.g., four ways to join wood together)
- shop tours and practice with machinery to gain experience
- ensuring that they examine sound designs, analyze both sound and flawed designs, and modify existing designs
- teach them about the properties of good design with lectures, texts and examples.

The only suggestion for resolving the time shortage problem was to have students modify an existing design rather than designing a project of their own.

Twenty-eight percent of teachers (10) also had **suggestions for overcoming problems related to lack of self confidence:**

- show them how to sketch and attempt to have them visualize with paper models
- build project step by step after learning the skills required
- make them examine things more carefully before they do something
- individual consulting and questioning (i.e., what object is used for, does it have everything they need on it, how could they make it better, and would they like to make it again their own way)
- other students show or tell them a method of doing a specific task
- praise them and accept their modifications
- encourage them to look at examples outside school (e.g., books, at home, in stores, catalogues, pictures)
- group discussion
- suggest different materials or combinations.

Nineteen percent (7) offered **suggestions to resolve the problem of limited or lack of ideas** included the following:

- give suggestions for new materials, processes or ideas for variations
- referring them to textbooks.
- tell them that their first idea is not always their best and criticizing it so that they will think of other possibilities
- try to change the "mind set" by illustrating creative and imaginative cars and buildings
- make them create sculpture having no specific function.

There were no suggestions for ways in which students could be made less impatient with the time required to design their own projects. However, five teachers (14%) gave **suggestions for coping with their students' grandiose ideas,** including the following:

- refer students to catalogues, shops, textbooks and project books
- simplify design and decrease the number of projects to help them achieve success
- if students do not listen to suggestions and warnings, then they learn by trial and error, and by not completing the task
- personal discussion, questioning and problem-solving with students on an individual basis.

Six teachers (17%) outlined the techniques they used to resolve **problems with drawing.** They use actual or full size paper instead of scale drawings, use grid paper and may let them make a model of paper instead of a sketch. Teachers give their students simple items which they can recognize and try to get them to sketch so that they can measure from it. Help is provided both individually and to the class.

Therefore the teachers had methods to resolve all of the most common difficulties, with the exception of students' impatience and unwillingness to take time to design.

Two of the core aims of industrial arts education are to give the students opportunities to: 1) apply abstract knowledge to concrete, practical problems, and 2) be involved in successful problem-solving activities.

Nine teachers (25%) did not report using any method to develop **problem-solving skills** in their students. The remaining teachers (75%) utilized a combination of five different strategies:

Methods to Develop Problem-Solving Skills	N	%
• **students work on projects to tackle difficulties in design and operations:**	15	42
- experiment with different materials and processes to pick the best one for project (e.g., fastening problems, type of joint best suited for purpose, kind of mold used, type of sandpaper)		
- consider cost factor		
- many of their own designs create problems along the way which we work through and discuss		
- give student a clue as to how to solve the problem (e.g., making clock out of 12 pieces of wood all at 30 degrees to each other)		
- direct observation of similar objects (e.g., examine tables or stool to investigate different ways of fastening top to the frame and then we discuss it in class)		
• **encourage students to fix their mistakes or redesign the object to incorporate the mistake**	7	19
- they cannot start over again if they break their project, but must solve the problem (e.g. re-shape the object)		
- give bonus marks for creative and functional solutions for errors		
- try things again		
- if they drop a bowl and it breaks:		
- grade 7's are shown how to glue piece on		
- grade 8's make a small piece to fit in		
- grade 9's redesign object for a different purpose or a different size		

	N	%
• **give general assignments to solve problems or to design a project**	6	17
- present them with a new "core problem" (e.g., develop a project to remove ice from car) - open-ended problems to which they must find a solution (e.g., desk organizer or wood of various colours in chessboard or cheese tray) - every project is a problem-solving exercise - break problems down into steps and think it through - group brainstorming; each student picks an idea and then they list what is needed to solve problem		
• **require students to give them different ideas or solutions to a problem**	6	17
- how to join pieces together in four ways - 3 or 4 ideas for lighting or reflector oven that can fit into a knapsack - give different shapes and materials for a project (e.g., pencil holder).		
• **teach sketching as a design method**	4	11
- make model to get good concept of how to construct object - discuss design of what is built - give design exercises, i.e., problems with limitations and practice with wood, metal, plastic or paper - problems to help them learn design and three-dimensional drawing.		

Summary. Seventy-five percent of teachers use a combination of techniques to instill problem-solving skills in their students. Difficulties in design and operation are tackled by discussion, teacher input, experimentation, and observation of a similar finished product. Teachers often encourage students to fix their mistakes or modify the object to incorporate the mistake. The solution generally depends on the grade level, level of skill and creativity of the student involved. Other problem-solving techniques include group brainstorming, and breaking projects into small steps.

Overall, the teachers are meeting the core aims of industrial arts education in that the students are involved in successful problem solving and apply abstract knowledge of design, materials and processes to practical problems. Most teachers (89%) felt they were very or partially successful in fostering creativity and most (81%) either gave specific design lessons or taught design incidentally. One third of the teachers stated that the majority of their students designed their own projects. Another 53% reported that students

often alter a design given by the teacher, with the proportion of students who design part or all of their projects increasing by grade level. A wide variety of techniques were used to encourage creativity and the use of design.

The emphasis for stimulating creativity and encouraging student design was on designing their own projects, altering teacher designs, problem-solving with multiple solutions, obtaining general ideas from other sources, groupwork and discussion, verbal encouragement, and teaching drawing and modelling.

The emphasis for the difficulties encountered by teachers incorporating a design component and for students creating their own designs was the lack of background, ideas and self-confidence of the students, the time factor, students' grandiose ideas, problems drawing, impatience, and unwillingness to take the time to design. These problems were resolved in various ways by some of the teachers. Overall, the industrial arts teachers are meeting the aims and goals of the industrial arts program with regard to design, creativity and problem solving, although some problems were reported.

Planning and Organization

Two of the aims of technological studies are to develop students' abilities to perform tasks using a logical sequence of operations and to develop the skills necessary to communicate ideas through verbal, written and visual expression. The development of students' capacity to analyze, plan, construct and evaluate useful objects of good design through the use of tools and materials is one of the core aims of education in industrial arts.

These aims are reflected in the North York Industrial Arts Guideline in that an important element of a comprehensive industrial arts program involves planning-related to practical work. The guideline states that planning should precede all practical work and that some form of visual communication regarding the project should be required. It is suggested that this communication will usually take the form of sketches or drawings, although other techniques such as models, mock-ups and/or photographs may also be used to advantage.

In order to determine the extent to which project planning is part of the curriculum, industrial arts teachers were asked to describe how students demonstrate that they have planned a project. Teachers were also asked to comment on the major difficulties experienced by students in planning projects and communicating those plans. Information was then requested about the help teachers typically need to provide to students.

As can be seen from the following breakdown of teachers' responses, all of the teachers who responded to the question (94% of the total sample) indicated that students produce sketches as a **demonstration of project planning.** Two additional techniques, which were each mentioned by slightly less than half of the teachers interviewed, involved students submitting a plan with dimensions or completing a written procedure sheet outlining the steps involved.

Activities related to project planning	N	%
. Sketches	34	94
. Plans with dimensions	16	44
. Written procedure sheet	15	42
. Discussion with the teacher (with no elaboration provided by the teachers interviewed)	13	36
. Models	8	22
. Written list of materials (in come cases including the bills of sale)	7	19
. Student states or describes the problems anticipated and discusses what is needed for solution; student discusses problems in actual construction	7	19
. Use of a picture file	1	3
. No response	2	6

The most frequently cited **difficulties experienced by students in planning their projects** involved problems related to drawing such as conceptualizing and visualizing abstract ideas and representing these on paper as three-dimensional objects (53%). Other frequently mentioned problems related to lack of knowledge and experience in industrial arts (25%), individual differences involving language skills, behaviour or motivation (17%), and students' difficulties accepting that planning is an integral part of the process (17%). A detailed breakdown of teachers' responses is provided below:

Project Planning Difficulties	N	%
. **Drawing difficulties including the following:** - representing 3 dimensional objects on paper - representing front and side views - poor sketching/drawing skills - visualizing actual size of object and providing correct dimensions - conceptualizing/understanding patterns - difficulty visualizing abstract project in entirety	19	53
. **Lack of knowledge and experience in industrial arts such as:** - difficulty adjusting work and locating materials - lack insight into layout so as to save materials - lack of knowledge of machines/equipment	9	25

	N	%
- difficulty understanding how to go about producing what the teacher wants based on abstract terms and designs - difficulty considering multiple factors involved in project i.e., aesthetic and functional design, cost restrictions, fabrication methods, and/or appropriateness of materials for particular design - students are unfamiliar with measurement in inches although many materials come that way		
• **Other individual differences among students such as:** - spelling, reading and writing skills - intelligence - appropriateness of behaviour - lack of self motivation or ability to work independantly	6	17
• **Difficulty accepting that planning is an integral part of the process requiring considerable time** - students easily frustrated because of time it takes to plan - students want to go straight to work or work from rough sketches without detailed planning - difficulty seeing far enough ahead to anticipate problems	6	17
• **Difficulty thinking of ideas for projects and in getting started; initial resistance to new and/or difficult processes** - problem may be greater for younger students - some lack self confidence and want to be told what to do	5	14
• **Students' expectations are too high** - design ideas are too grandiose - students want the project to look perfect/professional - parental pressure may be great to produce large scale, functional item	3	8
• **Poor organization skills**	2	6
• **Insufficient time**	2	6

A small number of teachers cited strategies to help students deal with the problems summarized above. A number of these strategies involved teacher demonstrations or individualized attention or discussion. Teachers also frequently mentioned having students who are experiencing difficulties work with one or more peers to develop ideas for projects or obtain assistance with particular tasks.

A small number of teachers mentioned strategies for dealing with specific areas of student difficulty. These are summarized below:

. **Drawing difficulties**

- use of photos as alternative to drawing
- provide drafting, sketching or orthographic drawing lessons
- practice simple pictorial drawing
- provide assistance with model-making
- have students resketch specific parts
- library resources

. **Lack of knowledge or experience in industrial arts**

- group brain storming/problem solving
- demonstrations of layout to conserve materials
- work with peer(s) to develop ideas
- repeat instructions and demonstrate as required
- if discussion of potential problems isn't convincing, students proceed and learn by their mistakes

. **Difficulty with planning**

- teach group lesson on problems that may arise

. **Difficulty generating ideas/resistance to new and/or difficult processes**

- allow them to copy existing project
- have student work with peer(s)
- have student ask parents for ideas
- provide ideas as last resort
- remind students of design parameters
- probe, ask questions to get students thinking

. **Students' expectations too high**

- suggest ways to modify, scale down or change aspects of project

. **Poor organization skills**

- mark note books twice per term to ensure students keep organized notes on materials, processes, safety, design and problem solving
- students keep daily procedure diary re safety, processes, planning, sketching and clean up.

Teachers were asked to comment on the **ways in which they encourage students to be organized in their work and in classroom management.** The vast majority of teachers (94%) provided comments about techniques used to organize students' work, in some cases listing multiple strategies. Sixty-one percent (22) emphasized planning and organized procedural steps, 36 percent (13) discussed organization with notebooks, and 11 percent (4) mentioned that their students work on a few projects simultaneously. Only two teachers (6%) did not respond.

Teachers provided a variety of comments about the **methods used to organize students' work through planning and procedural steps** such as those listed below:

- **students must go through logical sequence of steps in the design phase**
  - students may be encouraged to do planning at home
  - students need permission to proceed to next step
  - teacher discusses problems with students' ideas

- **work is completed in a logical sequence**
  - skills are taught in the appropriate order
  - students complete work in sequence

- **record-keeping by students**
  - daily record of procedures kept by student
  - students list tools used
  - students complete form regarding bills for materials

- **planning next steps**
  - students required to plan what they will be doing two days ahead of time
  - students who are behind due to poor time management must plan the next two or three steps before coming to the next class
  - students must bring necessary materials to class

- **students must explain why a solution failed**
  (e. g. time factor or because design was not on paper)

The comments of teachers who mentioned **notebooks as a means of helping students with organization** included the following:

- periodically review or mark notebooks for completeness and organization

- students not allowed to work in class without homework and notebook
  - students to refer to notes rather than always asking teacher

- notebooks may include:
  - formal written lessons
  - tests
  - table of contents and project sheets
  - package on each problem, record card for three year program, evaluation sheets and licenses for machines
  - separate sections for safety, planning/sketching and daily journal

Teachers' comments regarding **simultaneous work on several projects** generally involved students sharing machines and organizing their activities so that they keep busy using available equipment.

All but two teachers (94%) provided examples of **classroom management techniques to encourage their students to be organized.** Seventy-two percent (26) emphasized cleanup routines, 36% (13) discussed storage of tools, materials and projects, 17% (6) mentioned safety issues, and 19% (7) noted other student behaviour. Multiple responses were provided by most of the teachers.

Suggestions for organizing students with **cleanup routines** included the following:

- all students have a specific cleanup job, certain jobs of the beginning or end of class or responsibility for particular cupboards

- student supervisors given responsibility for cleanup activities
  - supervisor notes what is done on cleanup chart
  - supervisor marks others' cleanup activities
  - cleanup leaders given bonus marks if they do a good job
  - supervisors elected and responsible for smoothly running shop

- all students work cooperatively on cleanups, with no set schedule.

Suggestions for organization in the **storage of tools, materials and projects** included:

- organize tools so each one has its own place and it must be returned there after use
  - student supervisors may monitor organization of tools and storage
- students must report shortages or breakage of machines
- special storage room for projects and materials
- each class has one or two cupboards for storage and one student is in charge
- filing system with one drawer per topic, so students can find sheets for missed classes
- cupboards labelled and labels are listed in a directory, thus students can refer there if they are unable to find things.

Some suggestions for **safety** included having students complete a safety contract, write a test regarding safety rules and bring their goggles. Safety reminders are provided and students must follow safety rules when using machines.

Comments about organization of other **student behaviour** include:

- line-up outside class, then take attendance from a seating plan, short lessons at beginning of class, and then work in specific areas without wandering around class
- students setup their own routines around the base provided by teacher
- books put away before lesson
- need to be calm and organized when they enter shop, have a certain place to put things and mark their work with their number or name.

Hence, classroom management techniques to keep students organized involved cleanup routines, storage of tools, materials and projects, safety procedures, and regulation of student behaviour. The majority of teachers organized students' work with an emphasis on planning and following an organized set of procedures.

Teachers were asked what proportion of time they spent in **individualized learning, small group work, and large group instruction.** Eighty-three percent of teachers (30) were able to estimate the percentage of time spent in each of these three types of instruction. Their responses are summarized as follows:

PROPORTION OF TIME SPENT IN INDIVIDUALIZED LEARNING, SMALL GROUP WORK AND LARGE GROUP INSTRUCTION

Description of Weighting Scheme	N	% *
. Individualized Learning:		
80% to 90%	7	23
60% to 75%	12	40
50%	7	23
20%	2	7
10%	1	3
0%	1	3
	30	99
. Small Group Work:		
80% to 100%	1	3
20% to 35%	10	33
5% to 15%	11	37
0%	8	27
	30	100
. Large Group Instruction:		
75% to 80%	1	3
45% to 50%	6	20
20% to 35%	11	37
10% to 15%	11	37
0%	1	3
	30	100

* percentages based on 30 teachers

The predominant mode of instruction is individualized learning, with nearly one quarter of these teachers using that method about half of the time and almost two thirds using it 60 to 90 percent of the time. In general, a smaller proportion of class time is devoted to large group instruction: about one third of teachers use that technique 20 to 35 percent of the time; only one fifth reported using this technique 45 to 50 percent of the time. Small group instruction is the least frequently employed instructional strategy. More than one quarter reported not using this method at all. An additional 70% devote less than one third of class time to small group instruction.

The remaining 17% of the teachers interviewed reported either that the proportion of time spent using the above instructional strategies varied according

to grade level (2) or provided descriptive rather than proportion responses (4). The former two teachers indicated that the amount of individualized instruction increased by grade, while the useage of large group instruction decreased.

The descriptive comments made by the latter four teachers included:

- percentage depends on class situation and individual student needs
- most of my time is spent in individualized attention, some time in demonstration to the entire class for common problems and no time for small group instruction
- mainly small group and individual (fairly equal) instruction with some large group instruction at beginning of project
- mainly large group instruction at the beginning of the term, then individualized learning once everyone is working on their project (very little small group work).

Integration with Other Subject Curricula

Technological studies has a general aim the development of an attitude toward learning that will encourage a high level of integration between technological studies and other disciplines. Consistent with this aim, the North York Industrial Arts Guideline states that the program should effectively integrate practical applications of the student's learning in English, mathematics, science, and to a lesser extent, other academic subjects as well.

A comprehensive industrial arts program should also make some provision to incorporate the study of scientific principles with the program. Such study may be done on a formal research basis or done informally in conjunction with other aspects of the program. The North York Guideline indicates that scientific principles to be considered should include the study of basic electricity, home mechanics, use of jigs and fixtures, and mechanical principles (gears, levers, pulleys, etc.).

In order to examine the extent to which the guidelines regarding the integration of industrial arts with scientific principles and other subject areas have been implemented, teachers were asked a number of questions regarding the **relationships between industrial arts and other subject areas.**

One of the questions concerned the different ways in which teachers encourage their students to see the relationship between the activities in industrial arts and other subject areas, such as mathematics, science and English. One teacher responded that he does not do this, one stated that he does a little, and 31% (11 teachers) noted that they do so incidentally providing little elaboration. The remaining 64% of the teachers reported encouraging students to see the relationship between industrial arts and the following subject areas:

Integration of Industrial Arts with Other Subject Areas	N	%*
. Science	23	64
. Mathematics	23	64
. English	11	31
. Art	11	31
. History	5	14
. Family Studies - fieldtrip, projects and presentations	3	8
. Geography - materials and their origin	2	6
. Music and Drama	2	6

* based on total sample of teachers interviewed

All of the 23 teachers who answered by mentioning specific subject areas indicated that they help their students to see the relationship between **industrial arts and science** through one or more of the following:

. **scientific principles** (12 teachers)
- molecular motion; centre of gravity
- gases used in brazing and welding
- balance
- pressure (in welding)
- chemicals; scientific formulae
- unit on sound
- how physics affects what one can and cannot do with materials
- leverage
- metallurgy
- adhesion

. **properties of materials** (14 teachers)
- properties of metals, glues, chemicals, and plastics
- welding and metallurgy
- density of wood taught in science and demonstrated in industrial arts
  (i.e., what woods are used for what purposes)
- fibrous materials
- tree growth and structure (grain, annular growth rings)

. **other** (13 teachers)
- everyone must repair, recycle and refinish something
- joint projects with science and industrial arts; work on Science Fair projects in shop
- test run computer technologies in shop
- contact teachers if planning a program that is relevant
- building model rockets discussed in science
- fixing broken science equipment
- discussing science as it relats to industrial arts (e.g., manufacturing, types of wood and plastic, properties of materials)

All 23 teachers also stated that they encourage their students to see the relationship between **industrial arts and mathematics** through one or more of the following:

. **measurement** (21 teachers)
- when cutting and gluing wood
- working in fractions and metric units; calculating lengths

. **geometry** (7 teachers)
- clock layout, e.g., circumference of a circle
- apply geometry to design and layout
- angles and spatial relationships
- teach mathematics and relate it to industrial arts (e.g., scale drawing and geometry)

. **other** (9 cases)
- mathematics teachers tell students they can make projects in the shop
- ask students what they learn in mathematics
- teach mathematics
- make math relevant to them

Thirty-one percent of the teachers interviewed (11) listed one or more methods to assist their students to see the relationship with **English** such as:

- tests and reports
- marking spelling and sentence structure for assignments, notebooks, bills of materials, and procedural steps on projects.

Thirty-one percent of teachers (11) also listed at least one technique that they use to help their pupils see the relationship between **art and industrial arts:**

- drawing (e.g. designing cartoon characters)
- painting and finishing
- work with art department on special days, carnivals, building props and staging
- joint projects with art (e.g. sculptures, paint boomerangs made in shop)
- some industrial arts teachers also teach art and use scraps in Art class or have adjoining classrooms (e.g. share materials, equipment)
- art and industrial arts teachers provide mutual help with sketching and design.

Fourteen percent of teachers (5) outlined at least one method to encourage their pupils to see the inter-relationship of **history and industrial arts** through such methods as:

- fieldtrips to Saint Marie settlement
- Cedar Glen Outdoor education trip
- teach history of tools, machines, design and materials.

Teachers were asked to discuss any other ways in which they attempt to integrate their program with other subjects. One third of the teachers either did not answer the question or responded negatively. The 24 remaining teachers (67%) reported integrating industrial arts with one or more of the following subjects:

Categories	N	%
. Art[1]	11	31
. Science	8	22
. Languages - English technical report - "Reach for the Top" game - work with Special Education and Language Departments for ESL students	3	8
. History and Geography - e.g., bring them in as they relate to course and design project in combination with these courses (fort model built while they learned about France)	2	6
. Music - e.g., musical instruments and steel cutting	2	6
. Physical Education - build or repair equipment	2	6
. Other responses	3	8

Teachers were asked if they are able to coordinate their **introduction of measurement concepts** with activities in the math class. Eighty-six percent (31) indicated that they cannot plan things that way, 12% (4 teachers) said that they can occasionally or incidentally, and one teacher gave no answer. A few teachers provided reasons for not being able to coordinate coverage of measurement concepts. These related to timetabling issues, lack of time, and the fact that students have some knowledge of these concepts already.

A series of questions was asked in order to determine which scientific principles teachers consider and to discover if teachers have integrated their program with the science teachers. The first question concerned whether they teach the **basic electricity and home mechanics.** A total of 42% (24) reported that they do, with 19 of these teachers (28%) covering such topics incidentally or occasionally and 5 (14%) responding that they always cover this material in a planned fashion. The remaining 58% of teachers do not teach these topics due to time constraints.

Specific topics listed by the teachers who always teach these topics included:

- car and house maintenance
- basic electricity
- home mechanics and bicycle repair sessions
- wiring lamps

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1. The specific methods reported for integrating industrial arts with science and art overlapped with those previously summarized on pages 25 and 26. Thus, teachers' comments for the two questions have been integrated.

- low voltage currents
- techniques to hook up plugs, sockets and outlets.

Teachers who cover these topics incidentally commented that they do so if students ask questions or bring articles from home to repair.

The second question concerned whether teachers are able to introduce **other scientific principles** into their program, and to list these principles. Two thirds of the teachers interviewed indicated that they teach other scientific principles either incidentally/occasionally or in a planned fashion. Examples of principles given by the 28% (10 teachers) who stated that they always planned to teach other scientific principles include:

- levers and forces
- heat forming in plastic; blow forming
- material strength and stress
- injection molding
- molecular structure
- engineering principles; hydraulics
- how engines work
- effects of heating plastic
- tree growth
- metallurgy and alloys; electroplating
- friction
- alternative energy sources; solar heating.

Several comments were given by the fourteen teachers (39%) who stated that they teach other scientific principles occasionally or incidentally. Some provide instruction as the need arises on an individual basis depending on the project, whereas others use scientific principles but do not introduce them directly. Some examples of such principles are the following: strengths, grain and uses of wood; levers in gearing, reduction gears, energy and input/output force, soldering and metallurgy. Twenty-eight percent (10) stated that they do not introduce any other principles because of time limitations. Two teachers (6%) did not respond to this question.

A third question concerned whether industrial arts teachers consult with science teachers about overlap between students' science and industrial arts programs. Slightly more than half of the teachers interviewed do so either regularly (25%) or occasionally/incidentally (31%). Four of the teachers reporting regular contact with other science teachers were teaching science themselves.

An additional 17% (6) did not mention discussion with other science teachers but did report that they are familiar with the science curriculum because they have taught or are presently teaching that subject. The remaining teachers either do not consult with science teachers (22%) or did not answer the question (6%).

Several topics were listed by the teachers who noted that they always consulted with the science teachers, namely:

- levers
- gravity
- force
- metallurgy
- metal forming
- soldering
- compatability of materials
- how to regulate pressures in welding
- strength in various materials and when to use them.

Comments given by the teachers who stated that they talk to science teachers occasionally or incidentally included the following:

- asking their students about what they are doing in science
- encouraging them to work on Science Fair projects in the shop
- having overlap in terms of such topics as force, work, energy, gravity, pulleys, leverage and magnetism.

Thus, the industrial arts teachers are fairly successful in following the guidelines for demonstrating the relationship between industrial arts and other subject areas. For a variety of reasons, teachers are less able to coordinate the introduction of measurement concepts with mathematics teachers (12%) and teach basic electricity and home mechanics (42%). Slightly more than half of the teachers (56%) reported consulting with science teachers regarding overlap in material covered, with an additional number of teachers reporting that it is unnecessary to consult with science teachers because of their own familiarity with the science curriculum.

The development of the skills necessary to **communicate ideas through verbal, written and visual expression** is another of the general aims of technological studies. Teachers were asked what types of activities they plan in order to encourage varied communication styles. Most teachers provided multiple responses including the following:

Communication Styles	N	%*
. drawing and sketching	31	86
. written notes, assignments, essays, tests and planning	19	53
. oral/discussion and student presentations	16	44
. visual demonstrations by teacher	12	33
. models of metal, paper and pipe cleaners	12	33
. work with partner or in a group	5	14
. teacher lectures on safety, tools and materials	5	14
. take photograph of object to be made	3	8
. computer for box design and attendance recording	1	3

* % based on total sample of teachers interviewed

The main types of activities through which students communicate their ideas are drawing and sketching, written material, oral/discussion, models and student presentations. Visual demonstrations by teacher using overheads, films, slides, pictures, videotapes and actual (live) demonstrations in order to teach design, tools and materials are important ways in which teachers communicate with students.

Teachers were then questioned more specifically about the most common response, sketching. They were asked to detail how their program allows for progression in sketching across the grades. Four teachers (11%) did not answer the question. Two other teachers (6%) only taught one grade and thus comparisons across grades could not be made. The remaining 30 teachers (83%) gave details about the sketching done in each grade. Two broad categories of responses emerged in the analysis. The first involved freehand sketching (with or without measurements), drafting (instruments used) and computer drawing. The second category included isometric and orthographic drawing or progression to three-dimensional drawing.

As can be seen in the following table, the majority of teachers (58% of all teachers interviewed) made comments reflecting some aspect of both of these broad categories. Nineteen percent (7) limited their discussion of sketching to freehand sketching, drafting or computer drawing (Category 1), whereas six percent (2) discussed only isometric or orthographic drawing (Category 2).

Examination of the range of teachers' specific responses provides an indication of the extent to which there is a **progression in their sketching programs** across the grades. Thirty-four percent of all teachers discussed a progression from freehand drawing to drafting or from drafting to computer drawing. However, nearly half reported that students did only freehand sketches in all grades. A total of 36% discussed a progression from isometric to orthographic drawing or vice versa, or increasing complexity to three dimensional representation. Twenty-seven percent reported that students did only isometric or only orthographic drawings in all grades. Responses indicating a progression in sketching across the grades are highlighted below in boldface.

Progression in Sketching Program

. Teaching 2 or more grades:

	N	% *
- Category 1 (freehand, drafting, computer drawing)	7	19
- Category 2 (isometric, orthographic)	2	6
- Combination of Category 1 and 2 responses	21	58
SUBTOTAL	30	83
. Teaching only 1 grade	2	6
. No response	4	11
TOTAL	36	100

Breakdown for 30 Respondents Teaching 2 or More Grades

	N	%*
. Category 1: Freehand, Drafting, Computer Drawing		
- Freehand drawing	15	42
- Instruments or drafting	1	3
- **Progression from freehand to drafting**	**11**	**31**
- **Progression from drafting to computer drawing**	**1**	**3**
. Category 2: Isometric, Orthographic		
- Isometric	7	19
- Orthographic	3	8
- **Progression from isometric to orthographic**	**9**	**25**
- **Progression from orthographic to isometric ****	**4**	**11**
- **Drawing becomes more structured and progresses to three dimensions*****	[2]	[6]

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* Percentages are based on total sample of 36 teachers.

** Two of these teachers mentioned that they then return to orthographic drawing.

*** Multiple responses.

Summary. The two elements of a comprehensive industrial arts program, namely, Scientific Principles and Integrated Learning, are being addressed in a number of ways by the industrial arts teachers.

The first element involves formal or informal study of such scientific principles as basic electricity, home mechanics, the use of jigs and fixtures, and mechanical principles such as gears, levers and pulleys. The industrial arts teachers are only moderately successful in implementing this element of a comprehensive program. Forty-two percent teach basic electricity and hone mechanics, while many of the others do not do so due to time restrictions. Slightly more than half consult with science teachers regarding course content. Scientific principles are more likely to be taught incidentally and as required in the shop, rather than as a formal planned lesson.

The element of Integrated Learning specifies that practical application must be integrated with learning in English, mathematics and science, and with other subjects to a lesser degree. Science, mathematics, English and art emerged as the subjects most closely integrated with industrial arts. All teachers who responded encouraged their students to see the relationship with science by referring to scientific principles, properties of materials, and a variety of other methods.

The majority of teachers encourage their students to see the rel ·ship wi mathematics through the use of geometry, measurement and a var ·f othe techniques. However, none reported being able to plan the int ·on o measurement concepts directly with the math teachers due to time ·ions and timetabling .

Approximately one-third of the teachers interviewed listed at least c of helping their students to see the relationship between Engl industrial arts, including such methods as tests, assignments and note Over half of the teachers tried to develop in their students the sk necessary to communicate ideas through verbal and written expression throu assignments, tests, notes and presentations.

About one-third of the teachers listed at least one technique to help their pupils see the relationship between art and industrial arts through such methods as joint projects and sharing equipment and materials.

A few teachers mentioned that they encourage their students to see the relationship between industrial arts and history, family studies, geography, music and drama. In addition, some teachers stated that they attempt to integrate their program with such areas as history, geography, music, physical education and architecture.

A majority of the teachers try to develop in their pupils the skills necessary to communicate ideas through visual expression, such as drawings, models and photographs. More specifically, when asked to delineate the progression in sketching across the grades, teachers indicated that a sizeable proportion of students remain at the simplest level, producing freehand sketches (42%) or isometric drawings (19%). About one third reported progression from freehand to drafting or computer drawing. Slightly more than one third reported a progression from isometric to orthographic drawing, or increasing complexity to three-dimensional representation.

Evaluation Strategies

The North York Industrial Arts Curriculum Guideline specifies that "all work, practical and written, should be evaluated as a joint teacher, student consideration". Communication with the student regarding the evaluation of a practical project is considered to be an important element of a comprehensive industrial arts program which provides students with valuable learning experiences. The guideline also indicates that a variety of evaluation techniques may be used to assess students' theoretical knowledge, skills and practical work, ranging from oral and written tests and quizzes to evaluated practical or written research assignments, practical tests using tools, sample pieces, teacher observation, and student/teacher inspection of practical work.

Teachers were asked a number of questions regarding **techniques used to evaluate students practical work, theoretical knowledge, and shop practice or affective learning.** Information was gathered about the extent to which students evaluate their own practical work, as well as the proportion of the final mark that is based on students' practical, theoretical and affective learning. The manner in which teachers communicate with students about the basis for student evaluation was also discussed.

Fifty-eight percent of teachers (21) reported using a combination of teacher and student self evaluations to assess the quality of students' **practical work.** Twenty-two percent (8) use teacher evaluations exclusively, while a roughly similar proportion (19%) reported relying on student self evaluation exclusively. Fourteen percent (5) reported using evaluations by peers in addition to one of the techniques already mentioned.

A number of teachers described the components involved in students' self evaluations of their practical work. These included one or more of the following:

- what the student felt she/he learned
- possible ways to improve the project
- assessment of how project turned out
- evaluation of planning, creating, achievement, use of time and safety.

Teachers listed one or more of the following as factors in their evaluation of students' practical work:

- function
- appearance/finish
- creativity
- effort
- level of mastery of skills involved
- adherence to plan/accuracy
- utilization of materials
- planning
- use of time
- safety.

Teachers reported using various strategies to evaluate students' **theoretical knowledge** including written or oral tests (56%), research assignments, essays or other written work (17%), notebooks (8%) and an assessment of students' drawings, models or plans (8%). Fourteen percent mentioned a variety of other techniques such as students' problem-solving approach and discussions with students. One third reported that they do not directly assess the knowledge component. In a number of these cases teachers commented that practical tests (e.g. proper machine used in the correct fashion to perform a certain operation) provide evidence of the level of students' knowledge.

Fourteen percent (5) of teachers reportedly do not evaluate students in the **affective realm,** although two teachers (6%) indicated that they provide pertinent comments in students' report cards. Approximately 80 percent (29) rely on their own evaluations, although three of these teachers also incorporate evaluations by foremen/shop supervisors. One teacher reported that this mark is based solely on the foreman's evaluation, while another said that students evaluate themselves. Of the teachers interviewed, evaluations in the affective domain are made on a daily basis by 22% of teachers (8), at the end of term by 6 percent (2), and with unspecified frequency by 58 percent (21).

Seventy-eight percent (28) of teachers reported that they typically include evaluations of the practical, theoretical/knowledge and affective components in establishing a student's mark. The remaining 22% of teachers (8) base students' marks on one of the following:

	# of Teachers
- assignment of a holistic mark	4
- 100% based on practical work	2
- 50/50 practical and design	1
- 40/60 practical/affective	1

For the teachers who incorporate all three components in their marking schemes, the proportion of marks allocated to each area varied widely. Of the 24 teachers who specified the weights given to the practical, knowledge and affective components, only 21% indicated that the three components are weighted equally. The practical component alone comprises about half of students' marks for an additional one third of these teachers, and comprises at least 70% of the students final grade for another 29% of the sample who provided that information.

Half of the teachers indicated that the knowledge component alone accounts for between 20 and 33% of students' final marks. The affective component tended to be weighted less heavily on average; 42% of teachers based 20 to 33% of the mark on this component whereas another third of the sample allocated 10 to 15%of the marks to the affective component. Only one teacher indicated that the affective component is weighted more heavily than the practical and knowledge components. Teachers' responses are summarized in Table 1 (page 33).

The vast majority of teachers (92%) report that they **inform students about course evaluation strategies** at the beginning of the year. This is done through some combination of the following:

- class discussion
- provision of handouts
- copies of course outline
- copies of evaluation sheets
- overheads.

Slightly less than one quarter of these teachers also mentioned discussing evaluation at various times throughout the year in connection with specific projects or the daily evaluations of shop practice. The remaining 8% of teachers interviewed did not respond or answer the question directly.

Use of evaluation sheets is the most common technique employed to provide students with information about how their work will be evaluated. In some instances these evaluation sheets provide an outline of how they are to evaluate their own work; in other cases, two columns are provided, one for self and another for teacher evaluations.

TABLE 1

PROPORTION OF MARK ALLOCATED TO PRACTICAL, KNOWLEDGE AND AFFECTIVE COMPONENTS

		N	%
Does not include all three components		8	22
Include all components:			
Weight not specified		4	11
Weight specified		24	67
Description of Weighting Scheme:		N	% (based on 24)
Practical 70%		7	29
40% to 60%		8	33
30% to 33%		5	21
	Total	20	83
Knowledge 40% to 45%		3	13
30% to 33%		7	29
20% to 25%		5	21
10% to 15%		3	13
	Total	18	76
Affect 84%		1	4
50%		1	4
30% to 33%		5	21
20% to 25%		5	21
10% to 15%		8	33
Deductions from total mark		2	8
	Total	22	92
Combination Weights:			
Practical/Knowledge 90%		2	8
50%		1	4
16%		1	4
	Total	4	16
Knowledge/Affect 60%		1	4
30%		1	4
	Total	2	8

A few teachers provided examples of what they tell students about the criteria for doing well in the course such as the following:

- To pass, students must show they are trying, they care and they are listening - it is difficult to fail
- Information is provided about bonus marks, the amount of practical work required, types of tests and the importance of behaviour and attitudes
- Sheets for evaluation of practical work are explained, as is the type of work involved in the theory component. Students are provided with a written list of the points marked in the affective area.
- Grade 7 students are told they will not fail if they keep trying, whereas grade 8 and 9 students are told that "the more quality projects they make, the better their mark".

Only one teacher explicitly mentioned that the information provided to students about evaluation differed by grade level.

Safety

The aim of a safety program in industrial arts is to promote a sense of safety awareness among all students. The Industrial Arts Curriculum Guideline states that it must be a comprehensive, on-going program, involving regular use of safety lessons, films, charts, posters, quiz sheets, specific machine safety instruction, and constant personal reminders and observation. North York Board policy regarding safety is that all safety precautions, as required by Ministry Guidelines, must be observed.

Teachers' responsibilities with regard to safety include considerations related to program such as those listed above and facilities. Responsibilities regarding facilities include routine maintenance of equipment, good housekeeping and reporting hazards and defective equipment to the Maintenance Department.

The industrial arts guideline further recommends that all industrial arts students be issued with a list of general shop safety reminders which they may be asked to sign and date. In addition, it is suggested that teachers may wish to issue or post lists of specific safety reminders regarding each machine used. "Wear Eye Protection" labels must appear on all machines. The guideline also describes standard procedures to be followed in case of emergency, and the Report of Accident forms teachers are to complete when students are injured.

In order to examine the extent to which the industrial arts guideline regarding safety has been implemented, teachers were asked a number of **questions regarding the safety program they provide to students, the resources that have been helpful in the provision of that program and procedures followed when students are injured.**

Fifty-six percent of teachers indicated that their program includes major safety lessons at the beginning of the year with safety issues emphasized on a daily or "on-going" basis through two or more of the following:

- completion of a shop safety sheet, signed by the student and kept in the students' notes or on file
- safety lessons when the students learn about new machines or materials
- required use of goggles or safety glasses
- discussion of safety issues with the class when safety infractions occur.

Most of the remaining teachers indicated that they either emphasized safety on a regular basis with no elaboration provided (17%) or provided safety awareness lesson(s) at the beginning of the year plus one of the following (19%):

- class discussion of safety issues when infractions occur
- safety lessons when students learn new machines
- daily checks of all equipment

The remaining 9% of teachers (3) indicated that either safety issues are covered as the need arises or safety lessons are provided at the beginning of the year.

The majority of teachers (86%) indicated that students have safety rules/precautions available to them in concrete form. Many teachers provided multiple responses including the following:

	N	%
. notebooks containing the signed shop safety sheet and/or handouts provided by the teacher	23	64
. posters or charts throughout the shop	13	36
. signs, stickers or labels on or near machinery reminding students of relevant safety rules	9	25
. other responses (e.g. textbook, signed safety sheet kept on file by teacher) in addition to one or more of the above responses	3	8
. safety information not available in concrete form	5	14

Fourteen percent (5) of teachers indicated that students do not have safety information available in concrete form. In some of these cases the teachers provide safety information primarily through discussion since many students are poor readers, while in two instances the students' signed safety sheets are kept on file by the teacher. No other concrete sources of safety information were explicitly mentioned by these teachers.

Teachers were asked if they had ever used the **resources of the Industrial Accident Prevention Association.** Two thirds reported that they had, although in the majority of cases the resources used were limited to posters, plaques and signs (71% of those who reported using IAPA resources). Two or three teachers (between 8 and 13% of those using IAPA resources) reported using each of the following additional IAPA resources:

- bulletins, monthly newsletter
- booklets, brochures
- overheads
- other (i.e. guest lectures, cartoons, teacher attended IAPA convention).

Nearly twenty percent (7) of teachers interviewed indicated that much of the material available from the IAPA such as the Safety Certificate Program is designed for older age groups of industrial workers and is difficult to use with students. Some of these teachers have tried to use the Safety Certificate Program but are no longer doing so.

Half of the teachers interviewed listed **North York resources** as helpful to their safety program. The resources mentioned included the following:

	N	%
. other North York teachers and/or the Industrial Arts Program Leader	6	17
. videos, films, filmstrips on safety (in some cases the source was not clearly specified)	4	11
. the Safety Committee, meetings, the Program Leader's newsletter	3	8
. translations of safety rules into other languages	2	6
. periodic inspections of machines	1	3
. posters	1	3
. participation in the development of the North York Safety document for Technological Studies/Industrial Arts	1	3
. No North York resources listed as helpful	18	50

A small number of teachers described as valuable resources other than those provided by North York. These included:

	N	%
. films from Ontario Hydro	2	6
. the Ontario Industrial Arts magazine	1	3
. Safety Supply Canada (safety equipment for house rebuilding project provided free of charge)	1	3
. film entitled "Don't Press Your Luck" re eye protection	1	3

Teachers were asked to describe the **procedures followed when students are injured in class.** For minor injuries, 89% of teachers (32) report that they administer first aid (e.g. apply antiseptic and bandaids to cuts). Of these teachers, 22% (7) report that they also keep a personal record of all incident and/or complete an accident report and contact the office. One teacher commented that each occurrence and ways to prevent injuries are discussed with the class. The student is sent to the office to receive first aid by the remaining 11% (4) of all teachers interviewed.

For more serious injuries, 42% of teachers (15) report that they notify the office so that decisions can be made regarding treatment required. These teachers generally did not elaborate upon the steps involved, although four teachers indicated that they immediately shut off the power in the shop. The remaining 58% (21) indicated that they follow standard North York procedures including:

- the administration of First Aid
- notification of the office and parents
- the office decides whether further medical attention is needed and makes appropriate arrangements
- completion of the accident report form.

Two of these teachers mentioned additional procedures, in one case counselling the student re safety when she/he returns to class, and in another, focusing a subsequent class lesson on relevant safety issues and procedures.

Environmental Concerns

Teachers were questioned about the **ways in which they ensure that students address environmental concerns.** This question was based on the general aim of technological studies related to developing an awareness of issues in Canada related to applying technology to our natural resources. Because teachers' responses focused largely on issues related to safety, their replies are summarized below, rather than in the section concerning integration of

industrial arts with other curricula. Only 11% responded that they did this incidentally (2) or not at all (2). The remaining 89% reported using a variety of the following techniques.

Environmental Concerns Noted	N	%
. conservation of materials	16	44
. safe storage of materials and disposal of waste	14	39
. pollution and clean air in shop	12	33
. discussion of issues	5	14
. neat, safe and clean shop	5	14
. recycling of metal, paper and plastic	3	8
. careful use of hazardous materials	1	3
. topic covered incidentally or not at all.	4	11

Teachers emphasized the conservation of materials by:

- teaching how to design a project to save materials (i.e., design and layout)
- charging for materials over a certain amount
- make them correct errors by changing design, rather than starting over
- discuss from where wood and metal come and why they should not be wasted (e.g. shortages, waste during processing, species of trees in danger of extinction).

Comments emphasizing the safe storage of materials and disposal of waste focused on materials such as oily rags, sharp metals, toxic substances, oils, varsol, paints, cleaning solvents, spray cans, finishing materials, and scraps.

A number of teachers also mentioned pollution issues such as noise levels and damage to hearing, dust-removing systems in the shop and exhaust fans for fumes (e.g. toxic fumes forming from plastic, soldering, aerosal cans for finishing products and welding). Others mentioned that they discuss articles from newspapers and magazines on such topics as loss of farmland, the weathering of wood and metal, and the effect a project has on the environment (i.e., environment a concern when designing projects) in their classes.

Therefore, teachers are fairly successful in using a variety of techniques to discuss conservation of materials, safe storage of material and disposal of waste, as well as pollution and clean air in the shop. A smaller percentage of teachers use discussion of various topics, and stressing the importance of a neat, safe and clean shop, in order to develop an awareness in their students for the effect of technology on our natural resources.

Leisure Interests

One of the general aims of technological studies is to develop students' interest in technology for avocational as well as vocational purposes. Furthermore, two of the core aims of industrial arts education involve providing students with opportunities to develop leisure time interests and to apply abstract knowledge to concrete, practical problems. In order to assess the extent to which these aims are being met, industrial arts teachers were asked **what they do to foster out-of-school interests or leisure activities related to industrial arts.**

Before or after school programs were cited by 64% of teachers. The majority of these programs appear to be relatively unstructured, the stated purpose being to allow students extra time in the shop for one or more of the following:

- to work on assigned shop projects
- to work on extra shop projects or projects for other subjects
- to repair something they have brought from home
- to work on personal projects related to hobbies.

Two teachers indicated that students not enrolled in shop courses are allowed access to shop facilities during this time in order to work on projects for other subjects. Four teachers cited specific examples of the personal projects in which students are involved before and after school including making kites, boomerangs, chessboards, stained glass, whittling, refinishing projects, home repairs, spring bicycle repairs and computer-assisted drawing. The frequency with which the shop is open for before and after school activities is variable, ranging from one to four times per week. Approximately two thirds of the teachers who mentioned before and after school programs did not indicate the frequency (15 out of 23 teachers).

Half of the teachers interviewed indicated that the shop facilities are available during lunch period. Only one third of these teachers specified the frequency with which the shop is open at lunch, ranging from two to four times per week. The stated purpose of the lunch period program is similar to that described for the before and after school programs. In two cases the lunch program appears to be limited to winter or days when the weather is bad. In another instance the lunch program is limited to providing assistance to seniors involved in a Parks and Recreation program.

About thirty percent of the teachers interviewed provided examples of other activities to foster out-of-school or leisure interests in their students. The following are examples of the activities mentioned:

- Rocket Club run by industrial arts teacher
- taking students to craft shows and introducing students to photography through slide shows

- assisting students with Science Fair projects
- activity days which encourages leisure time pursuits (e.g. model building)
- providing students with information on where to buy materials, and what brands of tools to buy for home projects
- provision of technical assistance by shop teacher and students (sound, lighting, props) for plays put on by the school
- canoe-making
- June program ("when school is shut down") involving wood carving, glass etching and stained glass
- assistance to students in solving problems related to hobbies
- making artifacts, bowls and crafts like those found in an Indian settlement.

Additional General Comments

Slightly more than half (53%) of the teachers provided additional comments when given an opportunity to do so. Thirty seven percent of the teachers (7) who commented discussed **problems related to the time allocated to industrial arts and the impact of OS:IS.** Specific concerns expressed by individual teachers included the following:

- Some schools lack facilities for industrial arts
- Shop courses should be part of students' general education
  - enrolment in technical courses has been adversely affected by OS:IS
  - shop courses should be compulsory for at least four years to provide students with skills that are useful in their everyday or work lives
- Half of the grade 8 students take computers instead of industrial arts/family studies. If all students took industrial arts, the time allocated would be inadequate (20 hours)
- Co-ed industrial arts is beneficial but has halved the time allocated per student. Less work is covered although expectations are greater; reduced time raises issues of safety and behaviour problems.

Two teachers (11% of those who commented) expressed concerns about the lack of funding for industrial arts, in one case focusing on the need for funding to replace antiquated machinery, and in the other case focusing on funding problems arising when school administrators do not support industrial arts through adequate budget allocations.

Three teachers (16%) felt that the emphasis of industrial arts courses should be on student enjoyment, creativity and fostering self esteem through experiencing success. Another suggested that the North York guideline provides an excellent starting point from which to develop the individual interests and skills of students and teachers but the expectation should not be all students in all schools do everything.

A variety of other issues were raised by individual teachers including the following:

- inadequate procedures in the North York system for the recognition of teachers' extra efforts
- issues related to 1) safety and language skills of ESL/D students
  2) integration of special education students
  3) discipline
  4) class size
- inadequacy of the Ministry minimum teacher course requirements for teaching Grade 12 courses
- need for greater emphasis on technological changes (e.g. robotics, computerized lathes).

II. Questionnaire Results: Areas of Program Emphasis

Prior to the interviews, teachers were asked to respond to a short questionnaire regarding the degree to which the program they teach emphasizes various areas. Teachers also ranked these areas in order of importance. Their ratings of the degree of emphasis placed on each program area and rankings of priorities are summarized below:

AREAS OF PROGRAM EMPHASIS

	Not Emphasized %	Emphasized Occasionally %	Emphasized Frequently %	Ranking of Priority
Safety lessons/considerations	-	-	100	1
Shop routines/responsibilities	-	3	97	5
Projects/practical work	6	3	92	2
Encouraging student creativity	-	8	92	3
Evaluation of student work	-	17	83	7
Working with variety of materials	-	25	75	6
Designing and planning	3	25	72	4
Learning many different forming processes	3	25	69	8
Integration with other subjects	19	58	22	9
Study of scientific principles	22	67	11	10
Learning operations without making projects	53	42	6	*

* Not included in list of elements teachers were asked to rank.

Based on these two questions, safety considerations, student creativity and the making of projects are emphasized frequently and given a high priority. The element of shop routines and responsibilities is rated as receiving frequent emphasis but is ranked as a moderate priority relative to other areas. Integration with other disciplines and the study of scientific principles are emphasized less frequently and given a low priority.